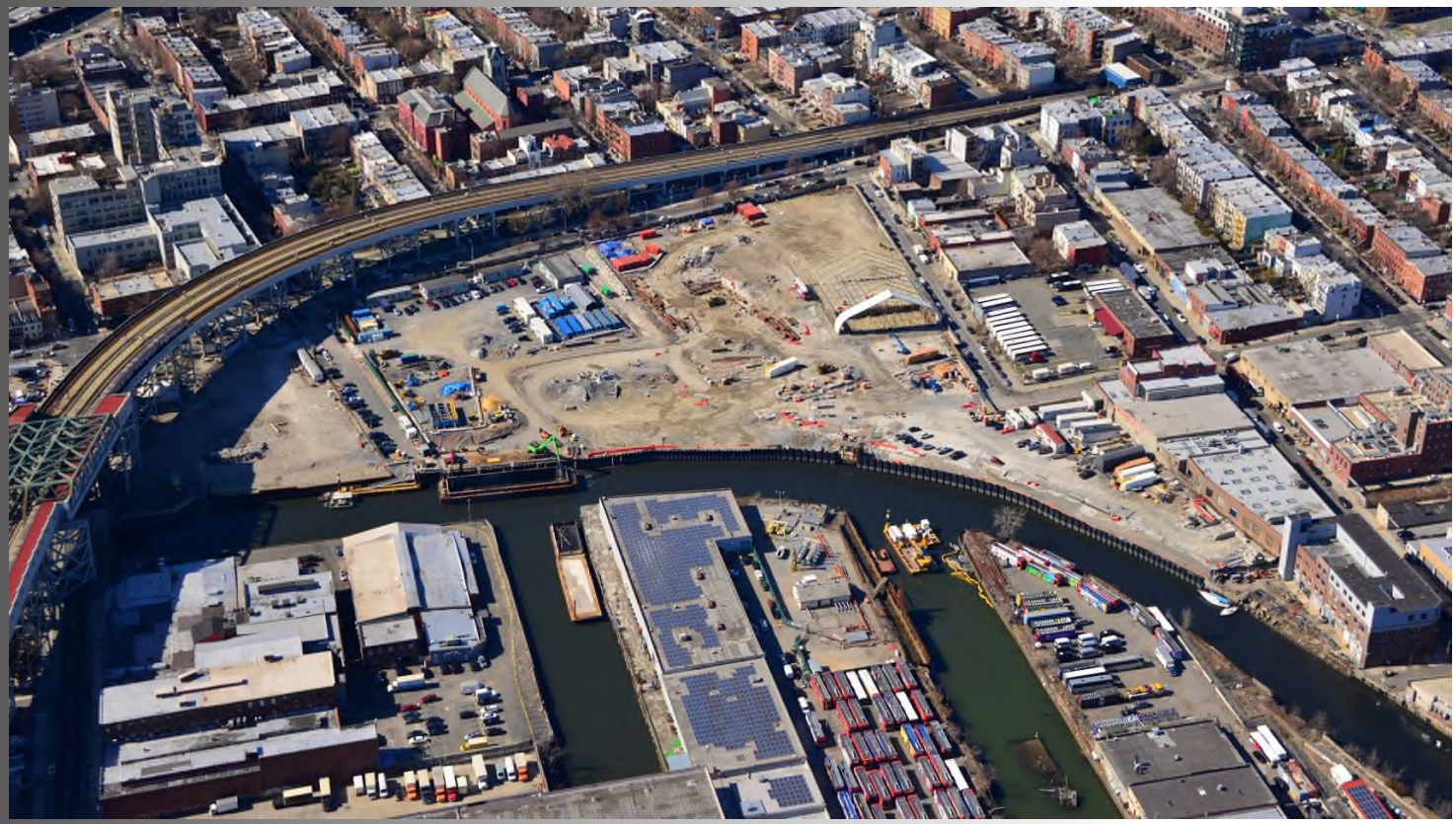
Citizens MGP Site Remedy

November 12, 2021



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Agenda

Follow-Up on Items Discussed During October 14, and October 18, 2021 Meetings

I. Proposed Redevelopment

II. Groundwater

III. NAPL

IV. Recap/Summary

V. Open Discussion

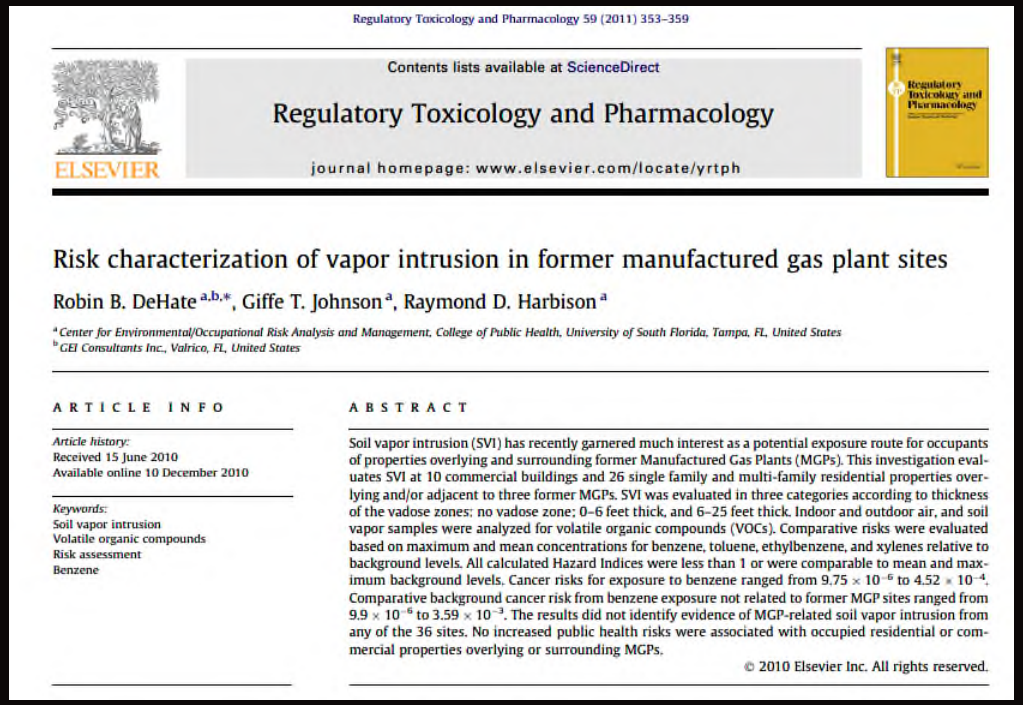
I. Proposed Redevelopment

Proposed Redevelopment

- Expected floor elevations will be above 100 yr flood elevation (School Ground Fl El. +17.0')
- Citizens hydraulic relief system mitigates groundwater mounding at the Site
- Simulated post-remediation groundwater elevations are approx. 9 feet lower than floor elevations of occupied spaces
- Property owners and developers are part of Brownfield Site Cleanup Agreement with NYSDEC
- Site Management Plan will address post-remediation ground-intrusive work

Proposed Redevelopment

- Typically, SVI not an issue at MGP sites – aligns with RI soil gas data
- Vapor mitigation systems to be proactively integrated into building construction
- Property owners and developers are signatories to Brownfield Site Cleanup Agreements with NYSDEC
- Developers legally required to comply with provisions of Site Management Plan



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Risk characterization of vapor intrusion in former manufactured gas plant sites

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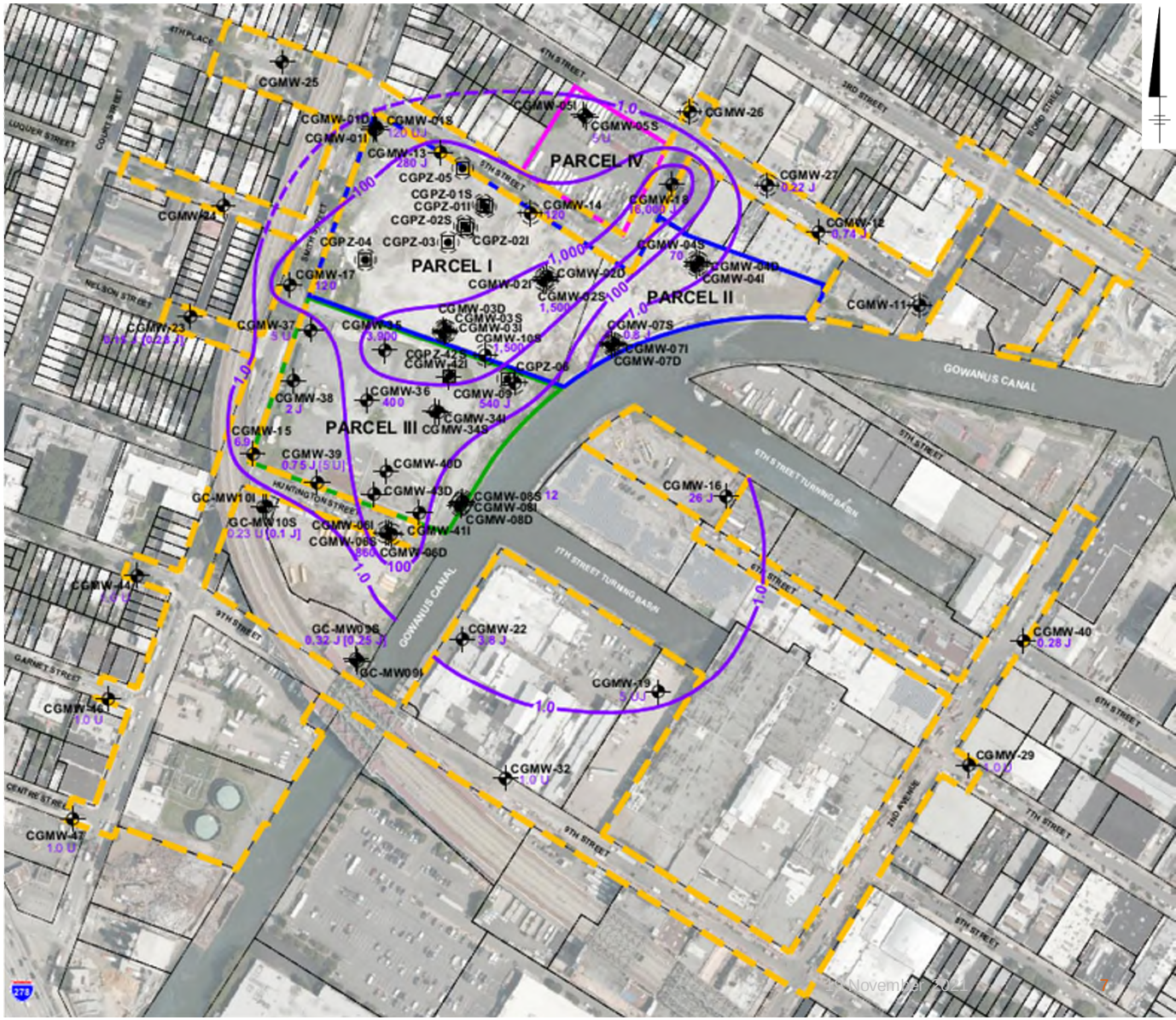
ABSTRACT

Soil vapor intrusion (SVI) has recently garnered much interest as a potential exposure route for occupants of properties overlying and surrounding former Manufactured Gas Plants (MGPs). This investigation evaluates SVI at 10 commercial buildings and 26 single family and multi-family residential properties overlying and/or adjacent to three former MGPs. SVI was evaluated in three categories according to thickness of the vadose zones: no vadose zone; 0–6 feet thick, and 6–25 feet thick. Indoor and outdoor air, and soil vapor samples were analyzed for volatile organic compounds (VOCs). Comparative risks were evaluated based on maximum and mean concentrations for benzene, toluene, ethylbenzene, and xylenes relative to background levels. All calculated Hazard Indices were less than 1 or were comparable to mean and maximum background levels. Cancer risks for exposure to benzene ranged from 9.75×10^{-6} to 4.52×10^{-4}. Comparative background cancer risk from benzene exposure not related to former MGP sites ranged from 9.9×10^{-6} to 3.59×10^{-3}. The results did not identify evidence of MGP-related soil vapor intrusion from any of the 36 sites. No increased public health risks were associated with occupied residential or commercial properties overlying or surrounding MGPs.

II. Groundwater

Dissolved-Phase Benzene Concentrations in Shallow Groundwater



LEGEND:

- LIMIT OF BROWNFIELD CLEANUP PROGRAM SITE NO. C224012 (PARCELS I AND II)
- LIMIT OF BROWNFIELD CLEANUP PROGRAM SITE NO. C224012B (PARCEL III)
- LIMIT OF STATE SUPERFUND SITE NO. 224012 (PARCEL IV)
- APPROXIMATE LIMIT OF OFF-SITE INVESTIGATION AREA
- PROPERTY LINE (APPROXIMATE)
- CGPZ-42S — EXISTING PIEZOMETER
- CGPZ-01S — FORMER PIEZOMETER
- CGMW-17 — EXISTING MONITORING WELL
- CGMW-02S — FORMER MONITORING WELL
- 1.0 — SHALLOW GROUNDWATER BENZENE CONCENTRATION IN MICROGRAMS PER LITER (µg/L)
- 1.0 — INTERPOLATED SHALLOW GROUNDWATER BENZENE ISOCONCENTRATION CONTOUR (µg/L) (DASHED WHERE INFERRED)

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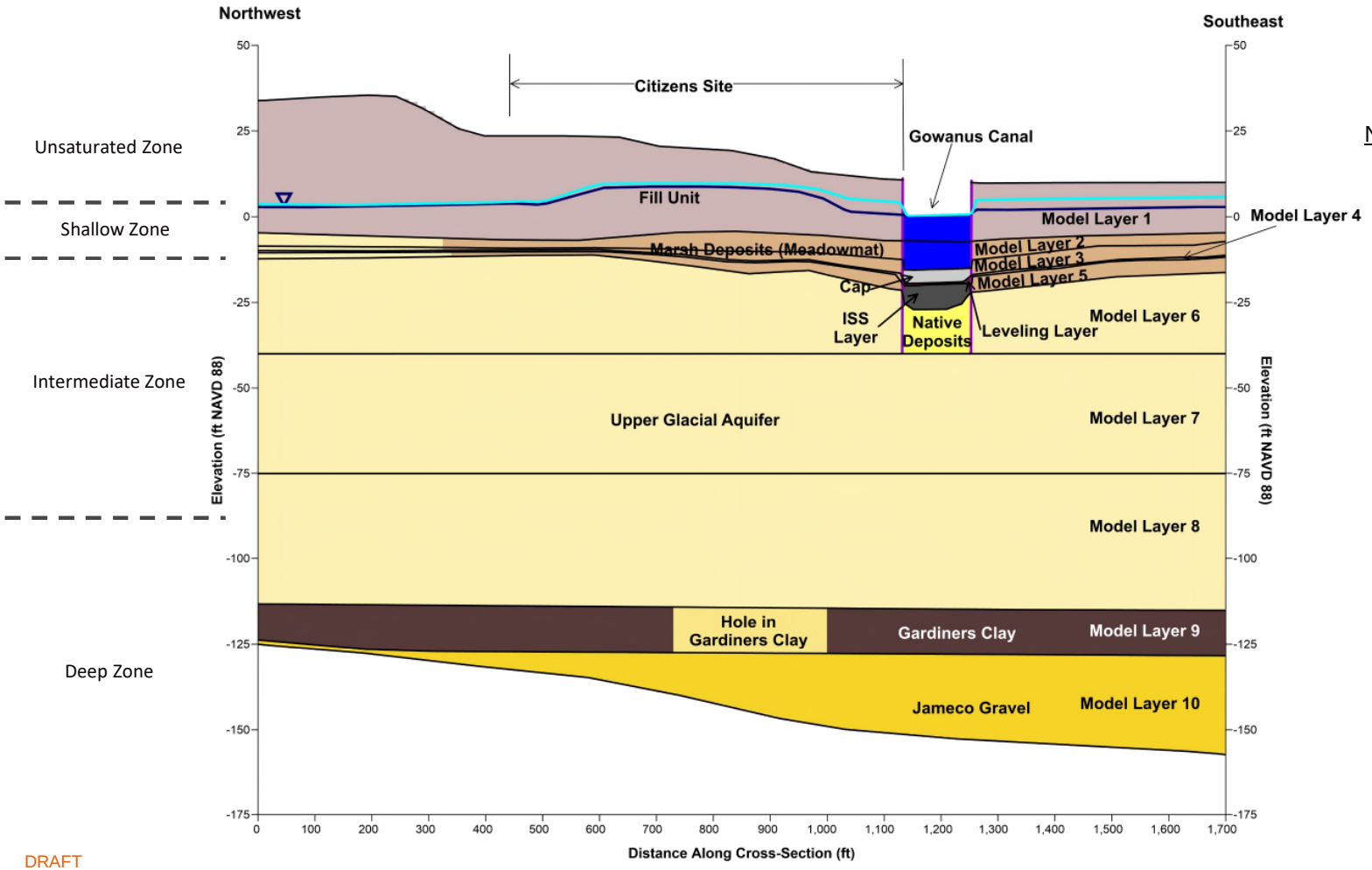
Citizens Groundwater Model Cross-Section

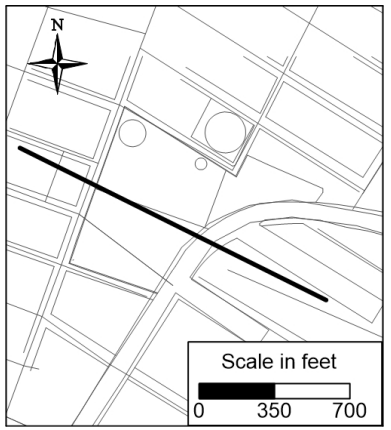


Note: Vertical scale exaggerated 6:1

Pre-Remedy Water Table

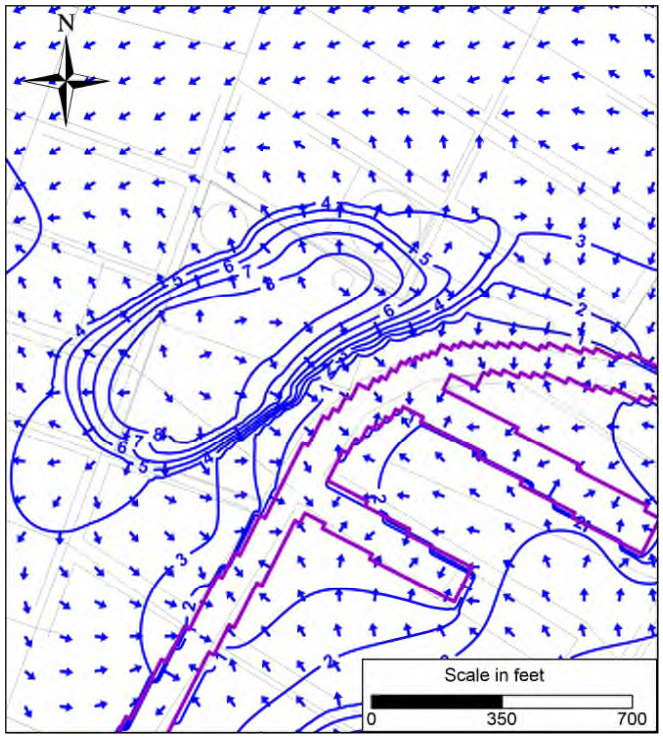
Post-Remedy Water Table

Cross-Section Location

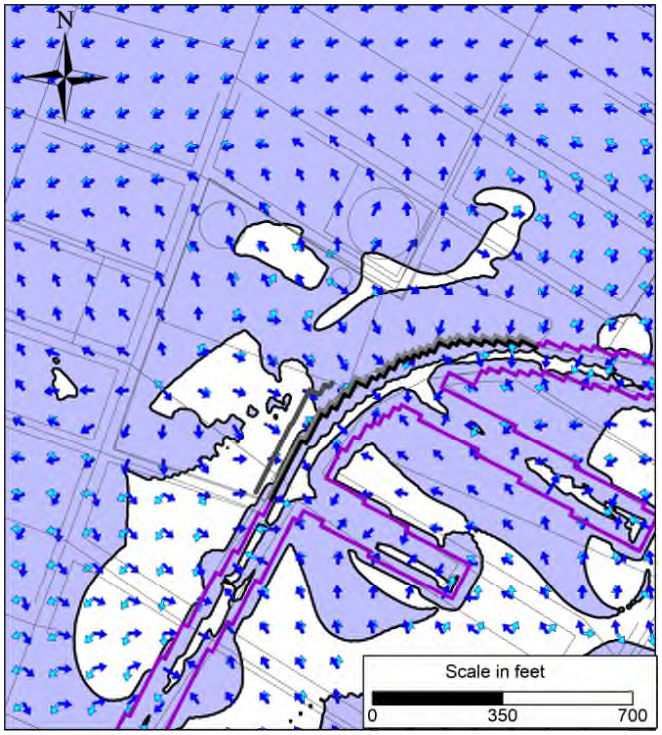


Minor changes in horizontal groundwater gradients at water table (Shallow Groundwater)

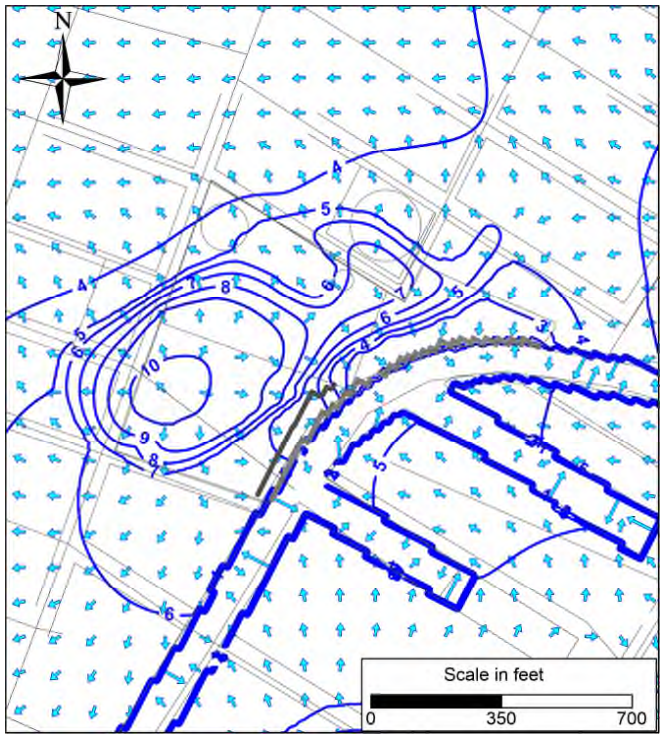
Pre-Remediation Conditions



Gradient Changes



Post-Canal Remediation Conditions



Horizontal Groundwater Gradient Vector for Pre-Remediation Conditions

Horizontal Groundwater Gradient Vector for Post-Remediation Conditions

Minor Change in Horizontal Groundwater Gradient Magnitude between Pre and Post-Remediation Conditions

No Change in Horizontal Groundwater Gradient Magnitude between Pre and Post-Remediation Conditions

Potential Exposure Considerations – Shallow Groundwater

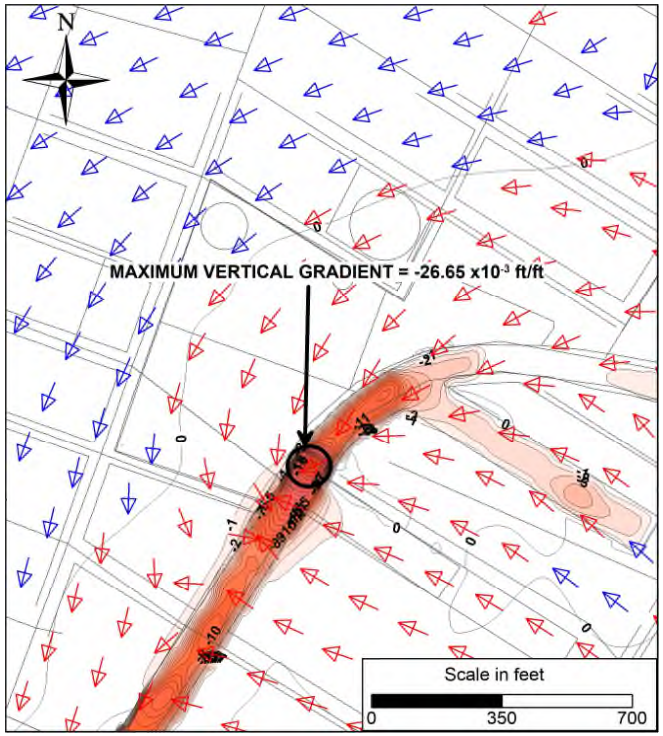
- Site Setting
- Area History – Urban Fill & Environmental Sites
- Groundwater Not Being Used
- Incomplete Exposure Pathways
- SMP for Post-Remediation Ground Intrusive Work

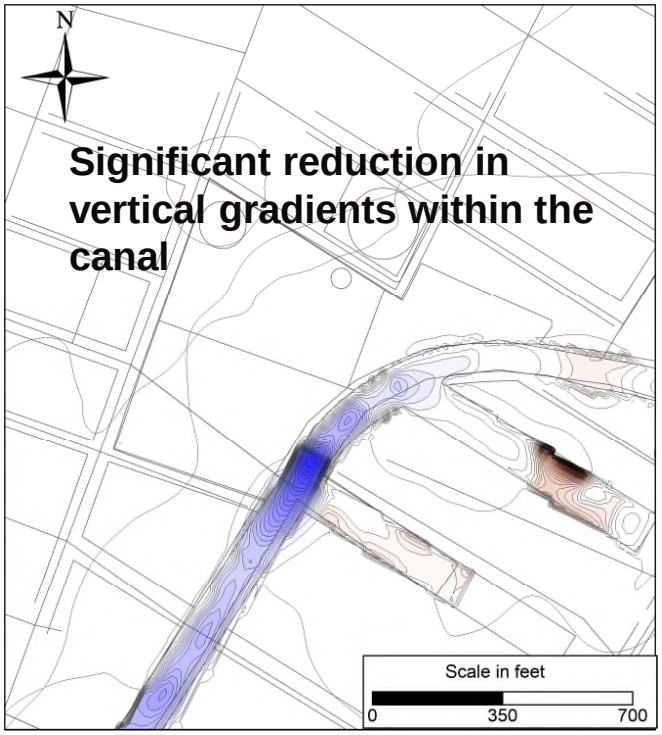
Vertical Gradients, Upper Glacial Aquifer – Mid Tide Between Model Layers 6 and 7

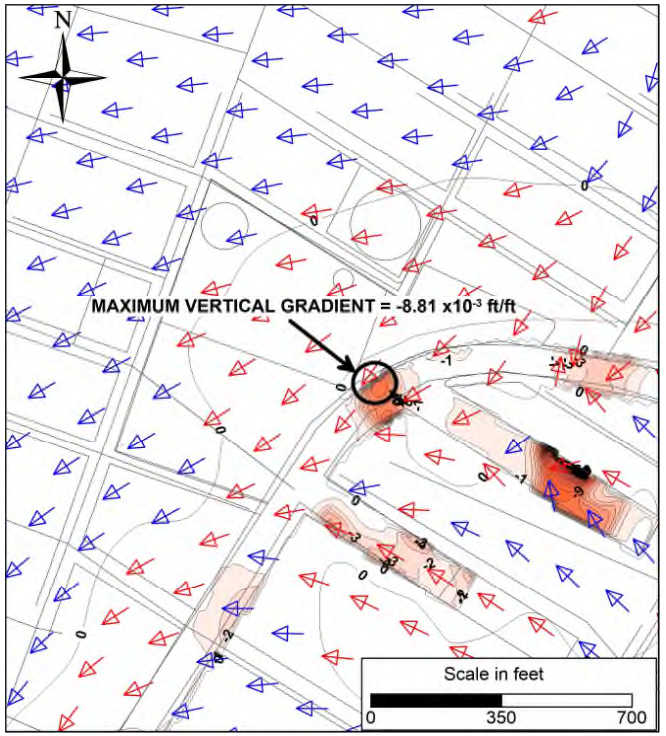
Pre-Remediation Conditions

Gradient Changes

Post-Canal Remediation Conditions

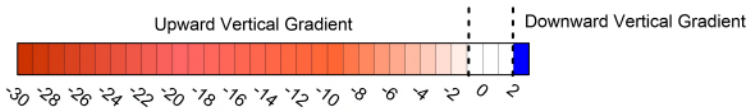






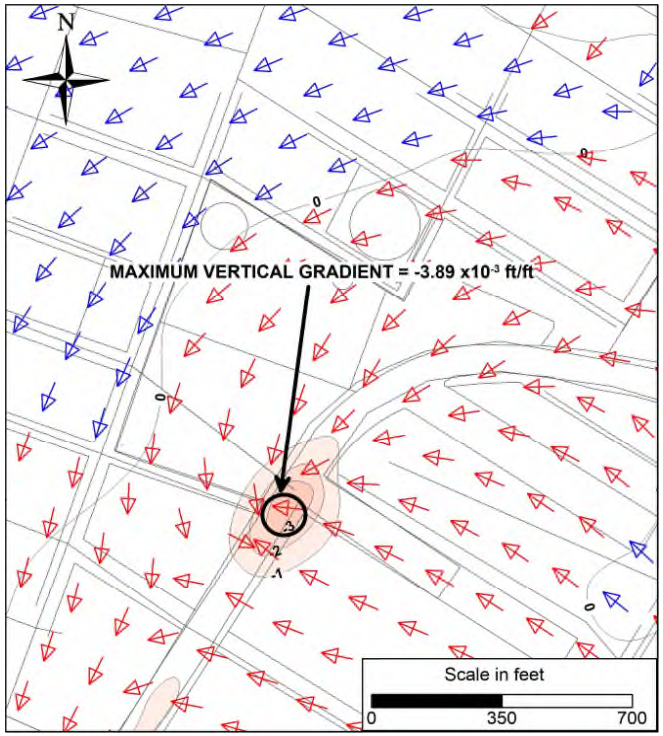
Vertical Gradients x 10^{-3} ft/ft

(e.g., vertical gradient of -30 on figure corresponds to vertical gradient of -0.03 ft/ft)

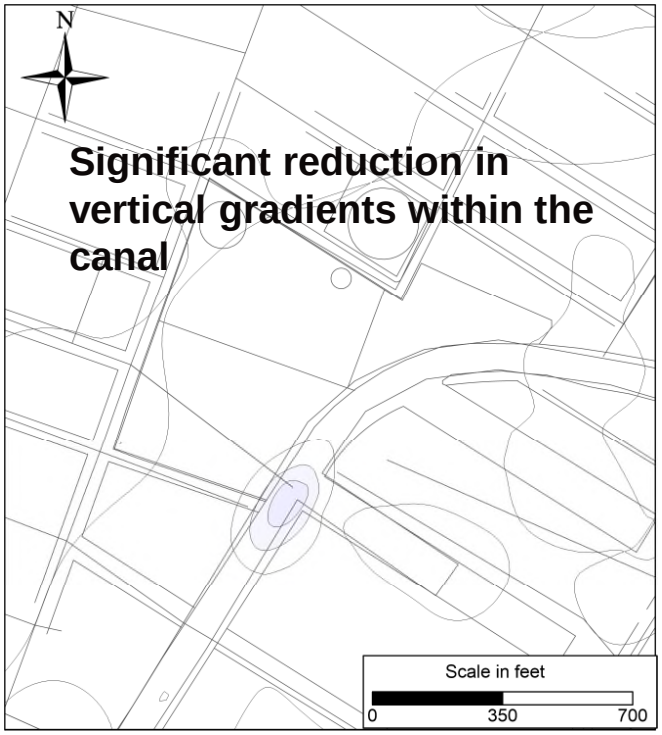


Vertical Gradients, Upper Glacial Aquifer – Mid Tide Between Model Layers 7 and 8

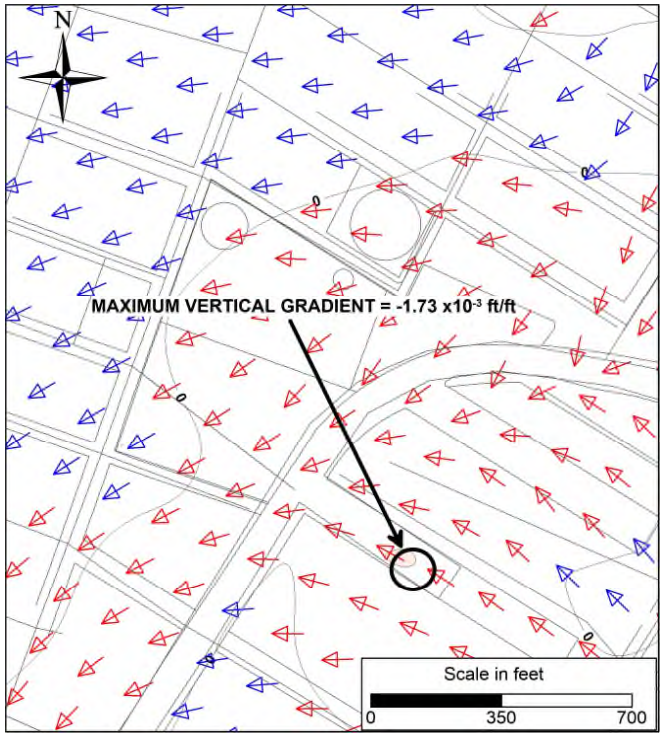
Pre-Remediation Conditions



Gradient Changes



Post-Canal Remediation Conditions



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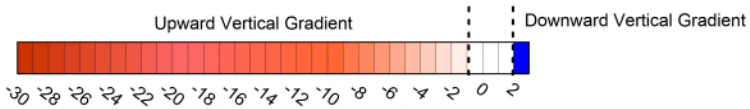


Groundwater Conclusions

Shallow Groundwater

- Limited dissolved phase migration off site
- Decrease in horizontal gradient following Canal remedy
- Incomplete exposure pathway

Intermediate Groundwater

- ISS in RTA2 including area near 9th Street Bridge
- Decrease in intermediate groundwater vertical gradient (>50% reduction)
- Incomplete exposure pathway

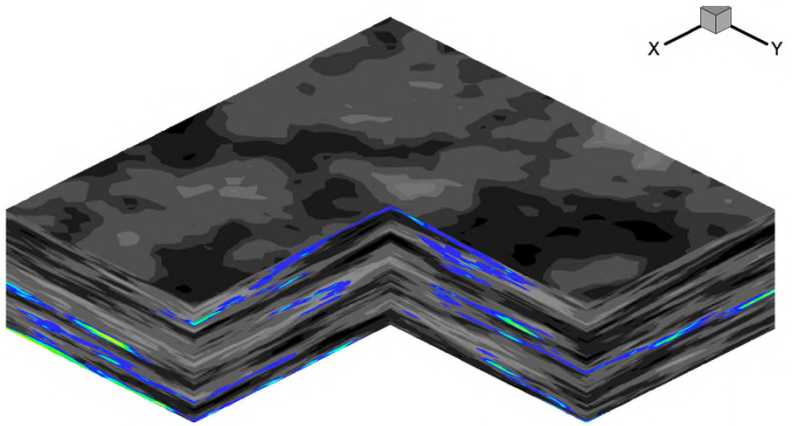
III. NAPL

Key NAPL Questions

Is NAPL likely to migrate upward toward the Canal?

Is NAPL likely to migrate beyond its current spatial extent?

Kueper et al., 1993



Richards et al., 2021

NAPL Migration Discussion

Key points:

NAPL migration is self-limiting due to finite mass

NAPL migration requires that capillary pressures exceed entry pressures

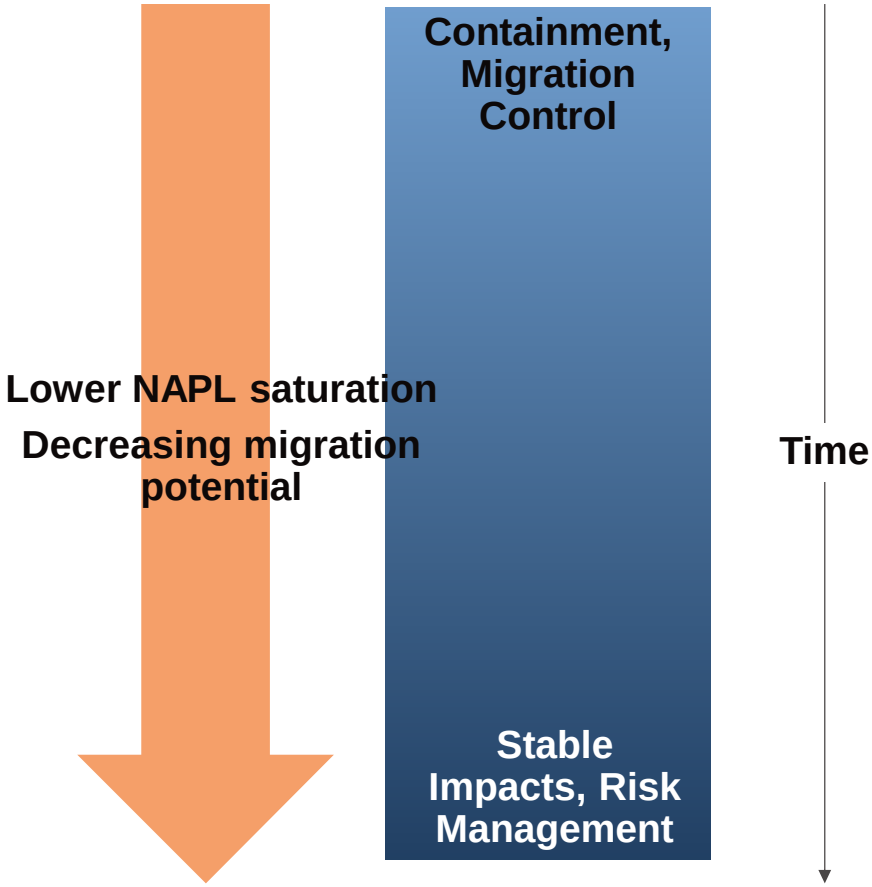
Both general experience/knowledge and site-specific data support an understanding that NAPL is stable in its current extent

- ❑ Is there sufficient NAPL to reach the Canal before dissipating to residual?
- ❑ Is there sufficient upward gradient?
- ❑ Is the geology conducive to upward flow?
- ❑ Would the NAPL migrate through the ISS layer?
- ❑ Would the NAPL migrate through the cap layer?

All of these conditions would need to be met for NAPL to reach the Canal

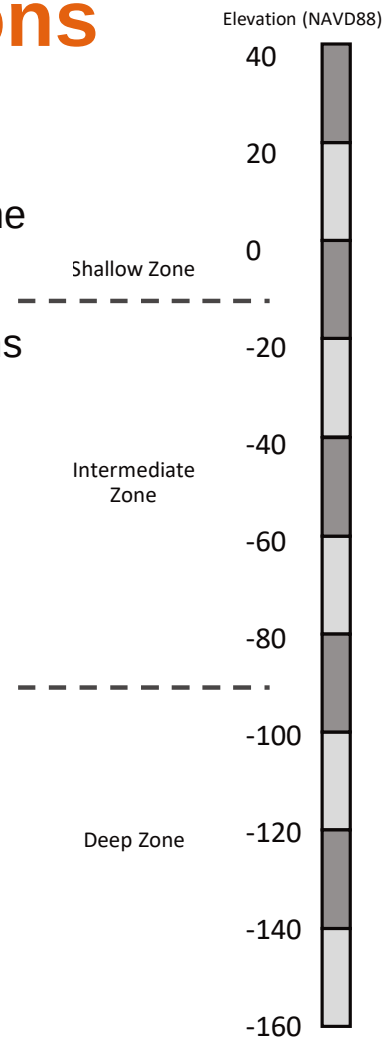
Sequence of Approved Actions to Address NAPL

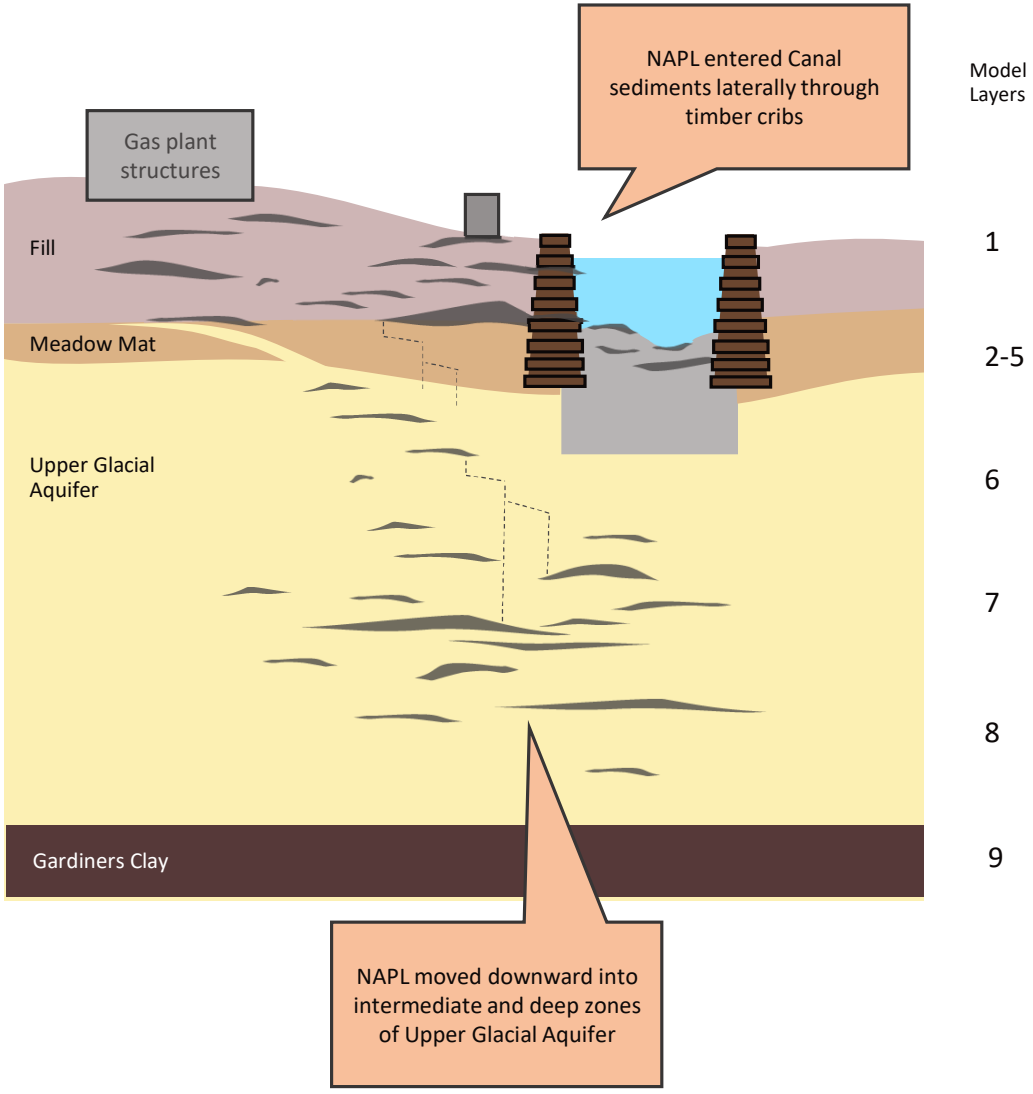
- Source removal/discontinuation – cessation of MGP operations and removal of process equipment
- NAPL removal from wells (48,000 gallons)
- Remedial excavation – removal of potentially mobile NAPL
- **NAPL mobility evaluation (physical properties, pore entry pressure calculations, viscosity, and interfacial tension)**
- **Bulkhead installation**
- **NAPL removal from wells**
- ISS and capping in Canal
- Long-term remedy monitoring & maintenance in accordance with SMP



Prior Conditions

NAPL historically entered the Canal sediments and the intermediate/deep zone through various mechanisms





NAPL Distribution

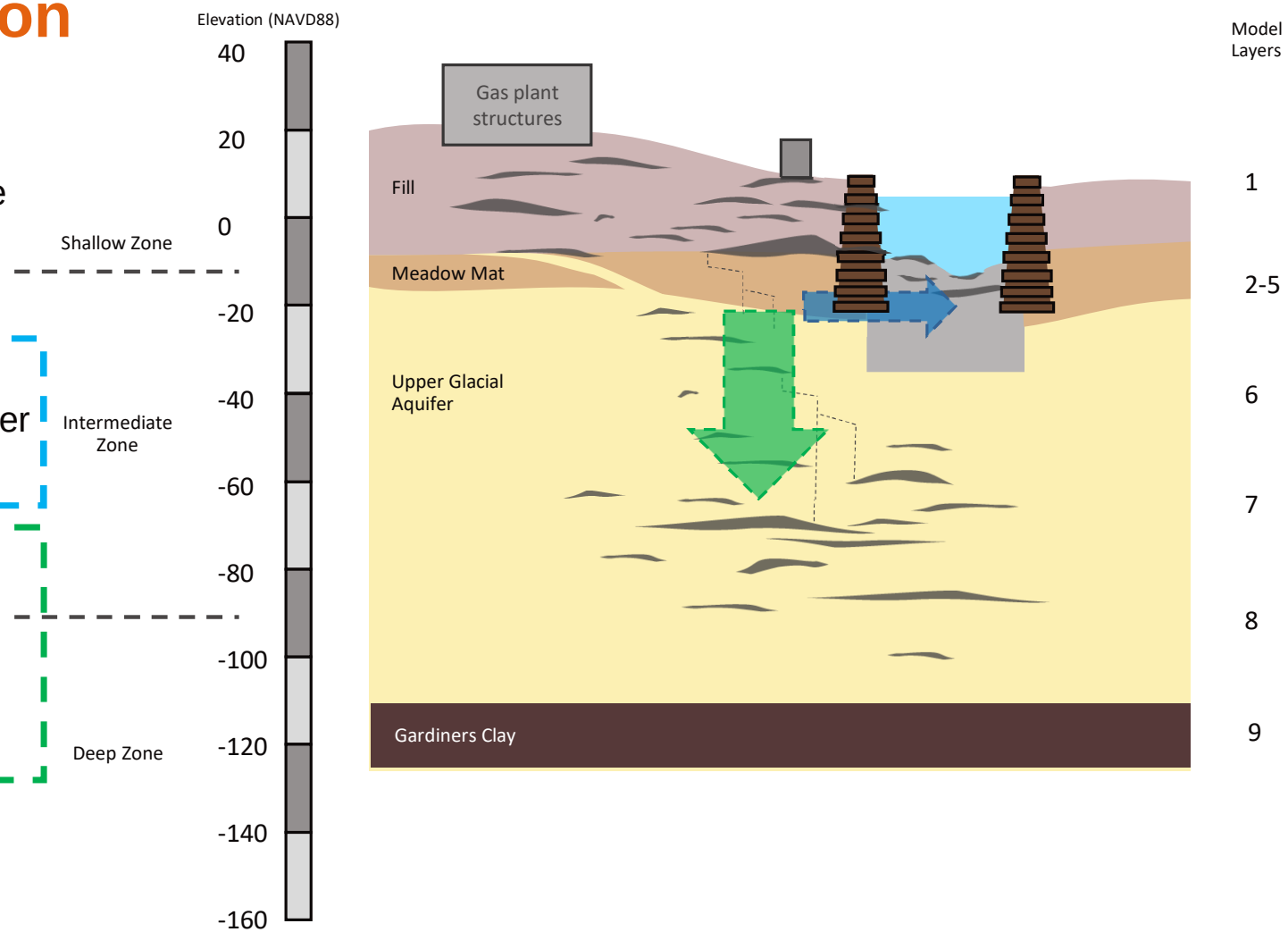
NAPL historically entered the Canal sediments and the intermediate/deep zone through various mechanisms

Canal Sediments

- lateral flow through timber walls

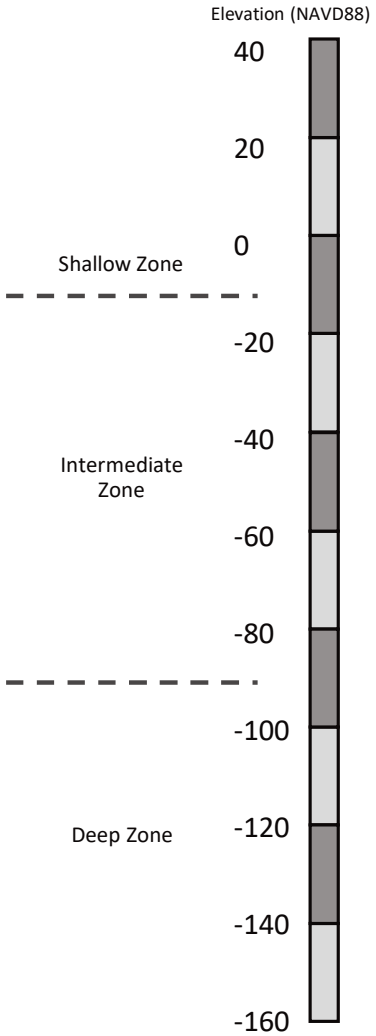
Intermediate/deep zone

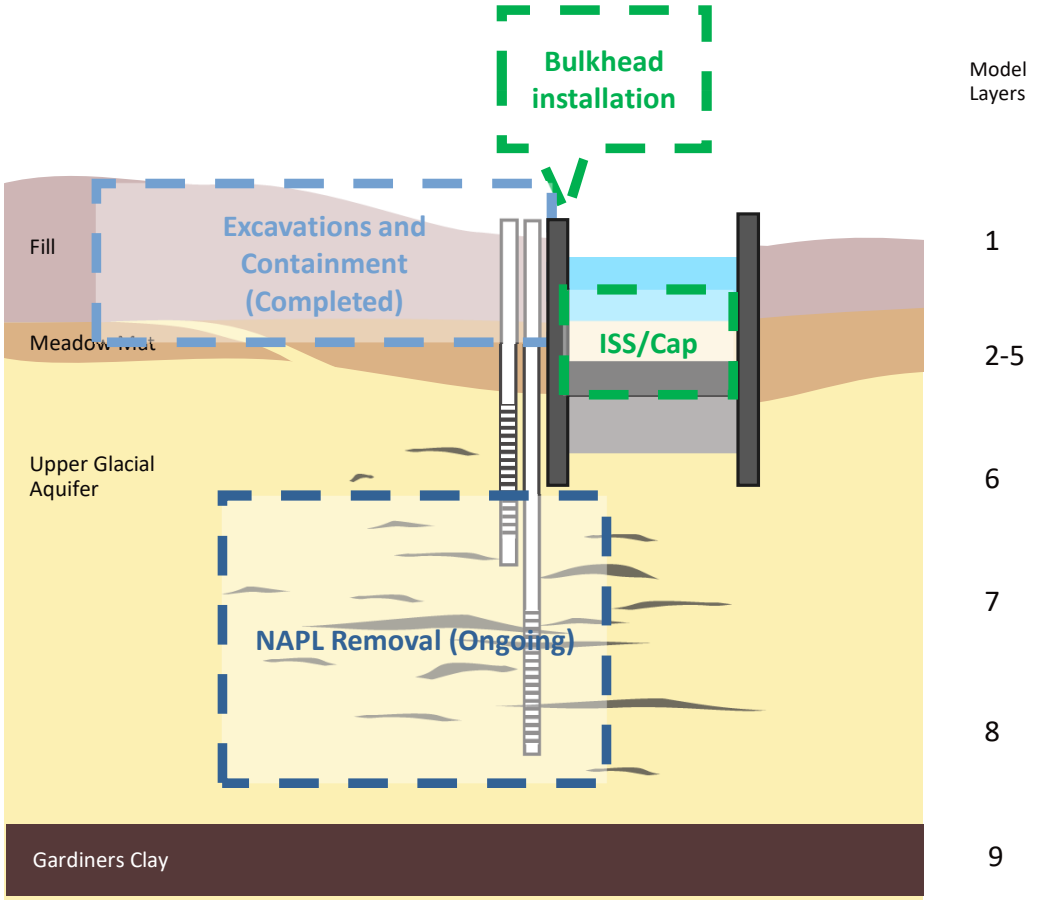
- density-driven downward/lateral flow
- geometry of permeable pathways



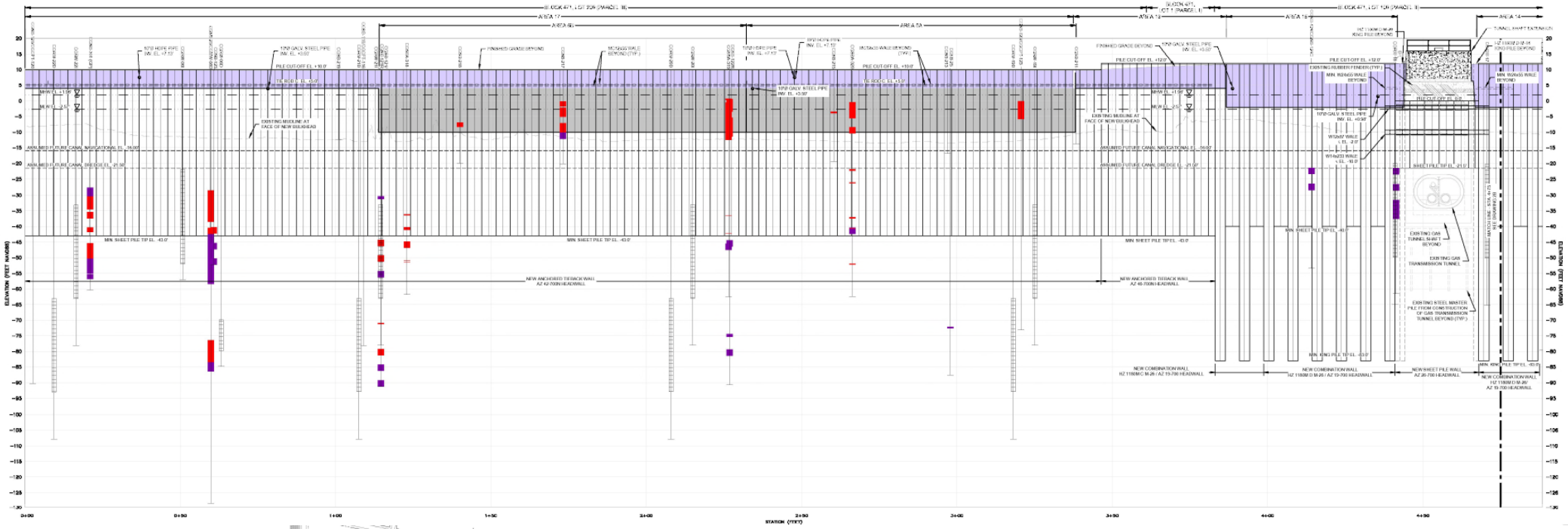
Approved Remedial Actions

- Remedial actions address appropriate zones of impact
- NAPL removal from wells in intermediate and deep zones will deplete accumulated NAPL and eliminate migration potential
- NAPL at depth is unlikely to migrate upward





Cross Section Along Citizens Bulkhead Barrier Wall



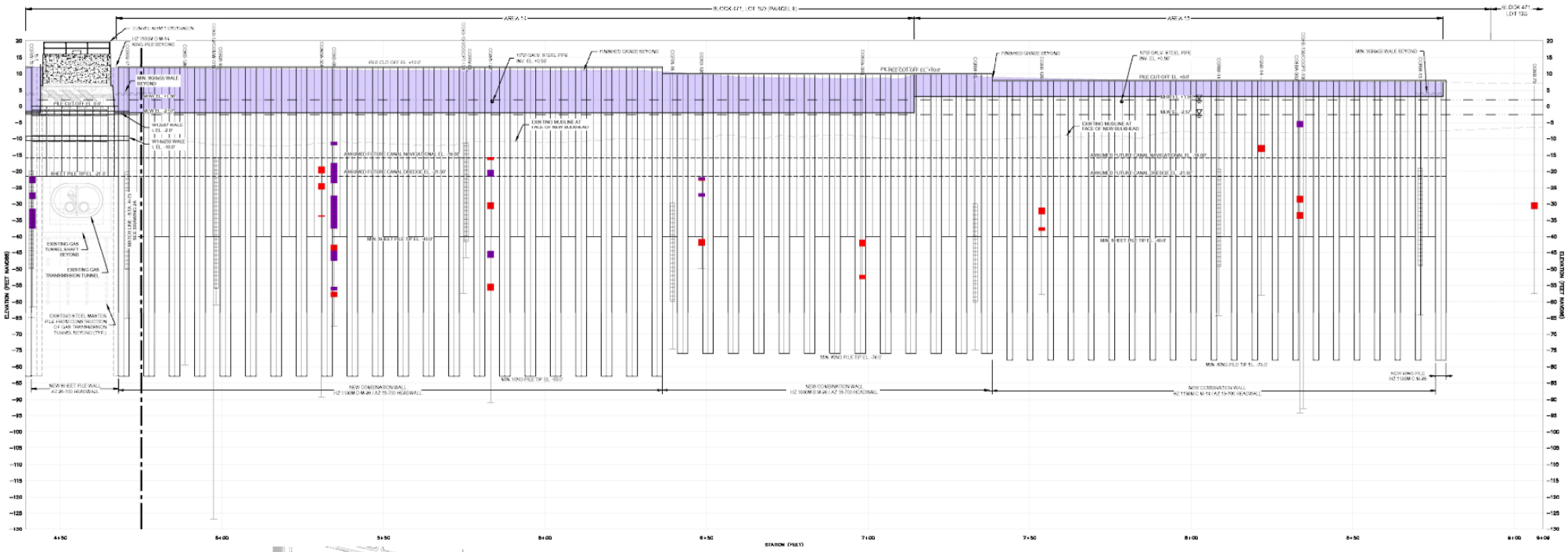
EXCAVATION AREA LEGEND:

- REMEDIAL EXCAVATION AREA INCLUDED IN 100% REMEDIAL DESIGN REPORT (APPROXIMATE)
- SUPPLEMENTAL EXCAVATION AREA COMPLETED DURING REMEDIATION PROJECT (APPROXIMATE)

VISUAL IMPACTS LEGEND:

- NAPL SATURATED
- NAPL-SATURATED LENSES

Cross Section Along Citizens Bulkhead Barrier Wall



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VISUAL IMPACTS LEGEND:

- NAPL SATURATED
- NAPL-SATURATED LENSES

Site-specific NAPL Data (Geosyntec, 2016)

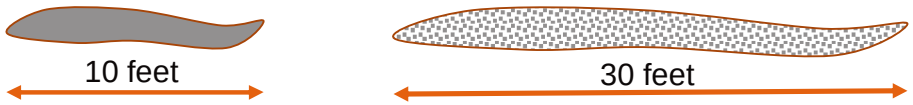
- From Citizens well UP-CGRW-06I:
  - Density 1.077 g/cc
  - NAPL/water Interfacial Tension (IFT) 13.2 dynes/cm / 0.0132 N/m (n = 1)
  - Viscosity 59.3 CPS / 55 cST (n = 1)
- RTA2 pore fluid saturation values 0.1% to 57.5% of pore space
- Porosity values average approximately 45%
- Measured RTA2 NAPL residual saturation approximately 3% to 20% of pore space

Geosyntec PD-8 NAPL Investigation Report (2016)

- “Temporary wells were installed within the native alluvial sediments in the Canal to provide a direct measure of NAPL migration and accumulation”
- “Migration of NAPL into the temporary wells was not observed”
- Geosyntec obtained NAPL from Citizens well CRGW06I for NAPL property testing
- Therefore, this provides supporting evidence of the unlikelihood of NAPL to migrate within the alluvial sediments within the Canal

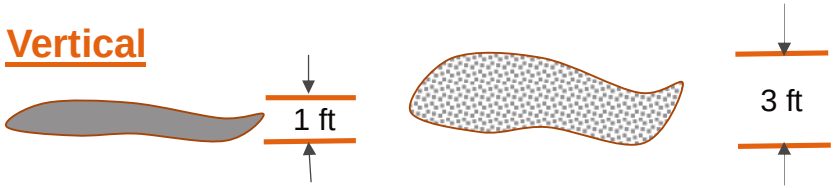
How Far Can Accumulated DNAPL Move (NAPL 60% of pore space)?

Lateral

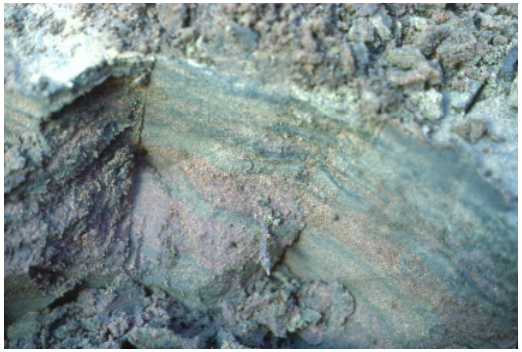


- Results in zone of residual NAPL at 20% pore space that will not move. 10 ft wide accumulated NAPL now distributed as 30 ft wide zone of residual NAPL.
- NAPL is not like groundwater, it does not exist everywhere and does not keep migrating

Vertical



- Results in zone of residual NAPL at 20% pore space that will not move. 1 ft thick accumulated NAPL now distributed as 3 ft thick zone of residual NAPL.



Vertical Hydraulic Gradient

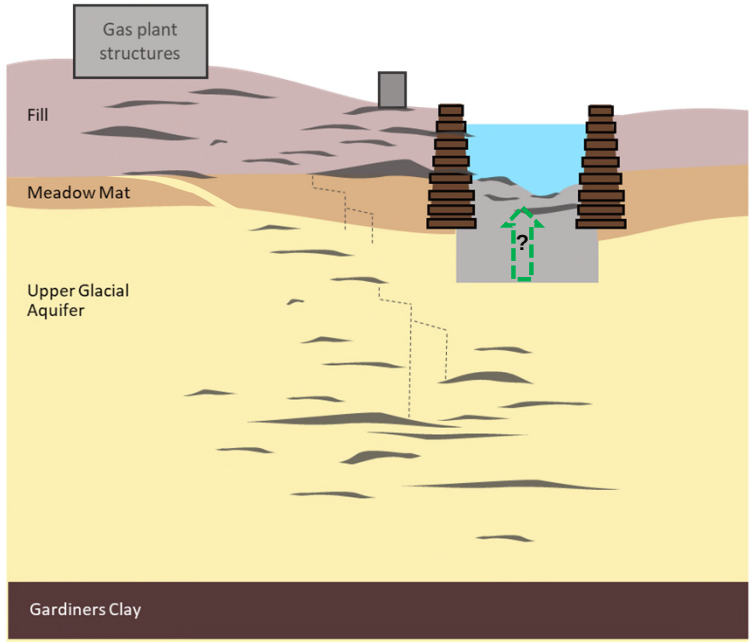
PD-8 Investigation (2016) concluded that ambient vertical hydraulic gradients could possibly mobilize accumulated DNAPL upwards beneath some areas of the Canal

However, the analysis did not consider geologic heterogeneity

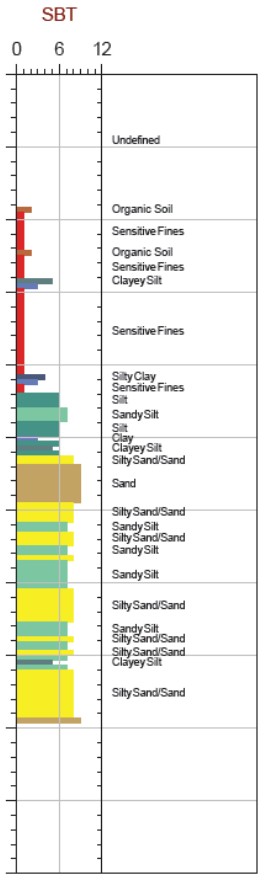
$$\frac{\Delta\rho}{\rho_W} L \sin\alpha + \Delta h > \frac{P_c(L) - P_c(0)}{\rho_W g}$$

Kueper & Gerhard (2014)

- $P_C(L)$ is a key parameter – Spatially variable due to geologic heterogeneity – Lower K has higher Pc(L)



Site-Specific Data Demonstrating Layered Heterogeneity Pc(L) is spatially variable



ConeTec (2015)

Geosyntec (2016)

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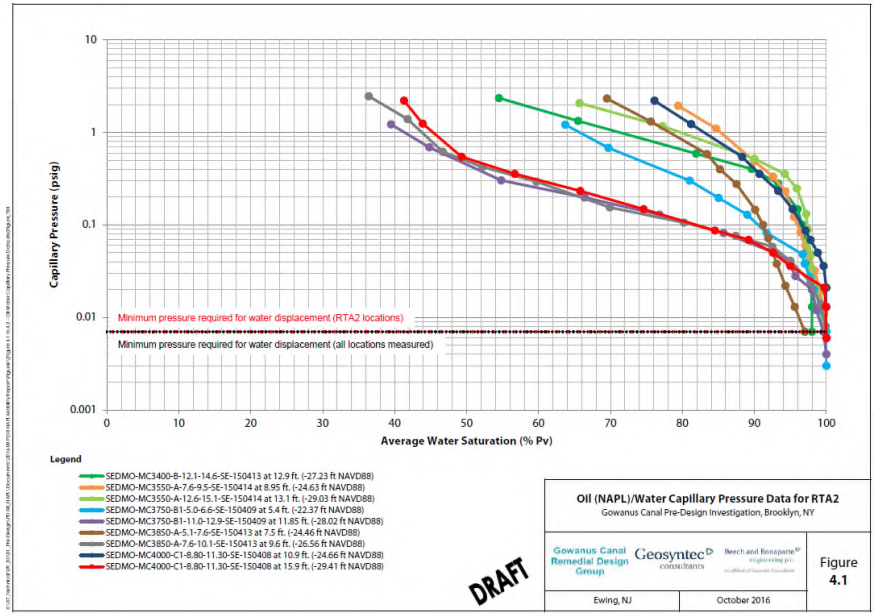
Geosyntec Capillary Entry Pressures

Measured RTA2 Air/Water entry pressures (Pe) range from approximately 0.5 to 1.0 psig (3,447 to 6,895 Pa)

Measured RTA2 NAPL/Water entry pressures (Pe) range from 0.04 to 0.3 psig (276 to 2,068 Pa)



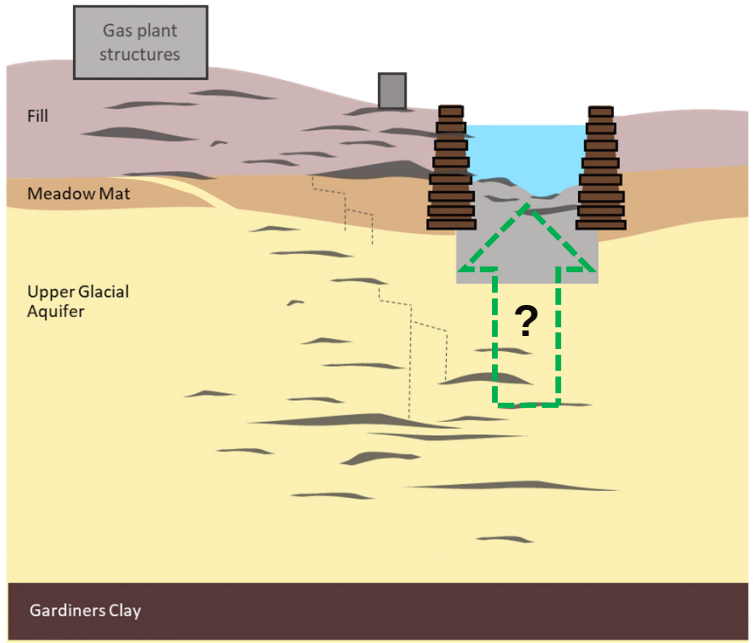
Vertical Hydraulic Gradient Required to Mobilize DNAPL

$$\frac{\Delta\rho}{\rho_W} L \sin\alpha + \Delta h > \frac{P_c(L) - P_c(0)}{\rho_W g}$$

Kueper & Gerhard (2014)

Example calculation with L = 1 m

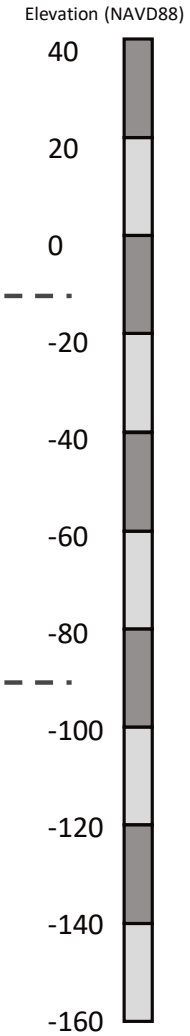
Pe (Pa)	Grad H
276	0.11
500	0.13
1,000	0.18
2,068	0.29

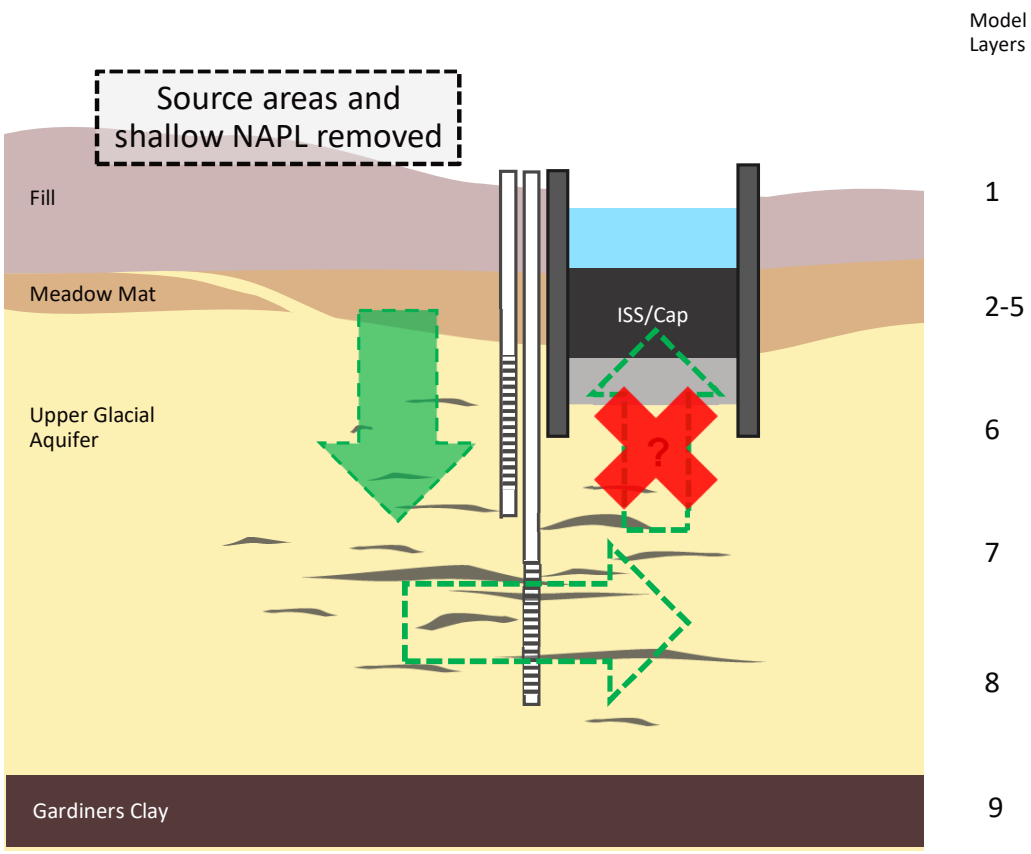


Recall: If DNAPL migrates upwards, it will dissipate itself to immobile residual within short distances.

EPA's NAPL Migration Comments

- EPA's current NAPL migration comment is whether upward hydraulic gradients beneath Canal could overcome NAPL/water density contrast and capillary resistance
- Groundwater model predicted vertical gradient between layers 6 & 7 is up to 0.00881 and between layers 7 & 8 is up to 0.00173
- Predicted upward gradients are less than gradients required to mobilize NAPL of 0.11 to 0.29





NAPL Conclusions

- NAPL mobility is not an issue
- NAPL from the Citizens site will not impact the Canal remedy
- NAPL recovery is an effective means for reducing the quantity of accumulated NAPL (where present) in the subsurface
- ISS layer will have high capillary entry pressure

IV. Recap/Summary

Recap/ Summary

1. NYSDEC's remedy (including the Canal remedy) does not result in groundwater mounding that impacts redevelopment.
2. SVI is not typically an issue at MGP sites. However, vapor mitigation systems will be integrated into building construction.
3. NYSDEC's remedy supports future use of the Site and obligates the future Site use to be in harmony with the environmental remedy.
4. Dissolved phase constituents from the Citizens site will not adversely impact the effectiveness of the USEPA's Canal remedy or pose an offsite risk to human health or the environment.
5. NAPL mobility is not an issue. NYSDEC's remedy prevents NAPL from the Site adversely impacting the Gowanus Canal Remedy and includes NAPL recovery to remove subsurface NAPL.
6. NYSDEC's remedy is protective of human health and the environment.

Conclusion: The agency-approved Citizens remedy is protective as designed

Questions/Open Discussion